JOINT STRIKE FIGHTER WEATHER DATABASE

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Overview

- Joint Strike Fighter (JSF) background

- JSF weather database "process"

- Insight and relevance to models

- Summary

JSF Background

- Leveraging opportunity for JSF
  - Air Force Weather methods and databases
  - Actual *and* forecast weather
- HQ USAF/XOWX signed on to help
  - Data for Dec 95 simulation
 - New focus on finer resolution for close battle

JSF Weather Database "Process"

- Define requirements
- Select historical weather data
- Analyze historical weather data
- Produce JSF weather input database
- Verify, validate, and adjust
- Baseline database pedigree

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JSF Requirements

- Hypothetical geography, terrain, weather
  - Composite of 39 countries
  - Potential "threats" and "friendlies"
- Categorical cloud ceilings and visibilities
  - Resolution of about 100 nautical miles
  - 90 days of actual and forecast weather
  - Three time intervals per day
  - Six weather categories

Hypothetical JSF Geographic Area
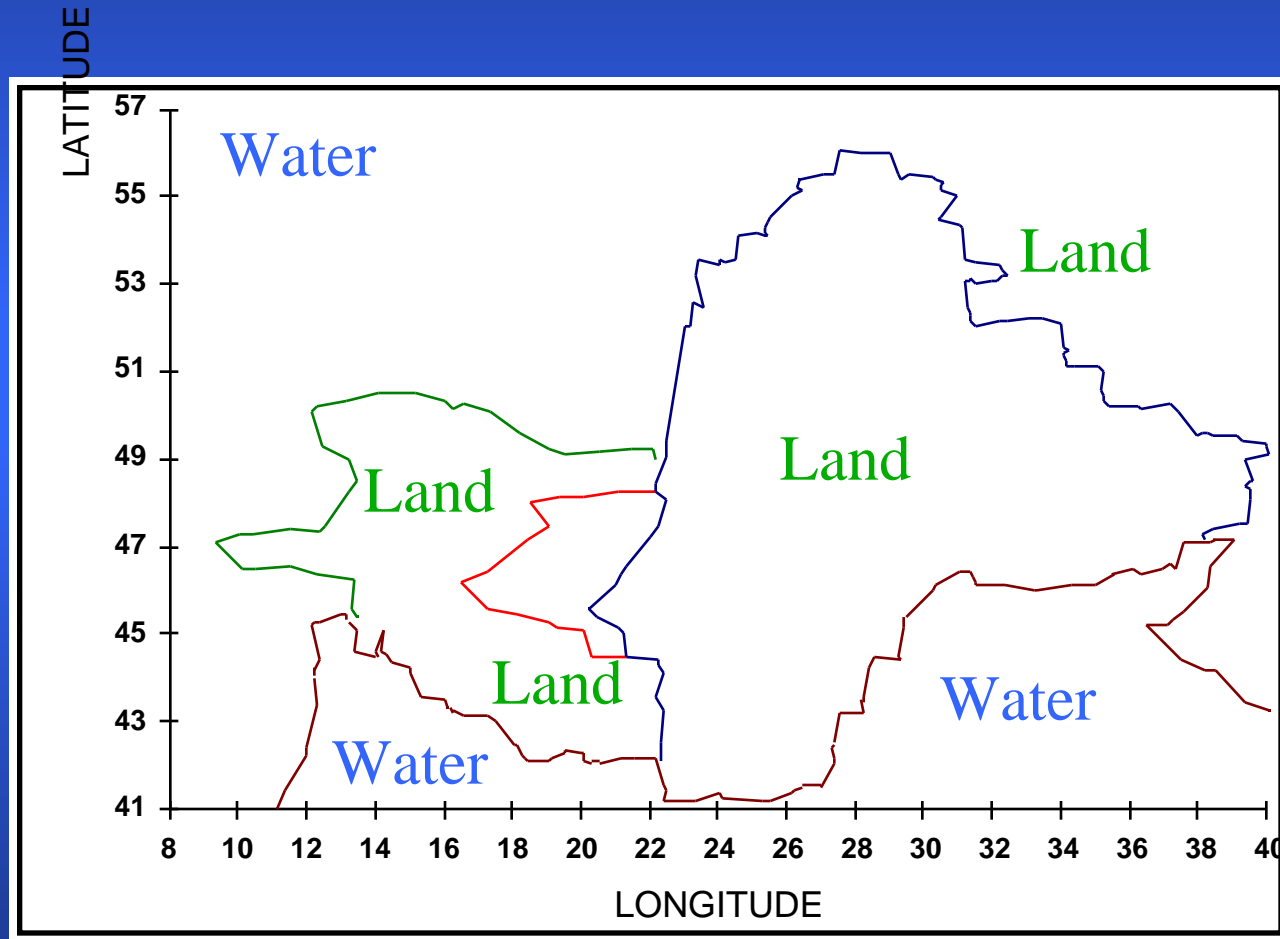
JSF Weather Database Categories

Band	Ceiling (feet)		Visibility (miles)
1	0 - 500	and	< 3
2	500 - 1500	and	< 3
3	1500 - 3000	and	< 4
4	3000 - 6000	and	< 5
5	6000 - 12000	and	< 5
6	12000+	and	< 5

Historical Data - Actual Weather

- 1973-1992 period of record
    - One station per country
- Ceiling and visibility
    - Frequency for each weather category
        - By month (Jan, Feb, ..., Dec)
        - By time of day (00-06, 12-18, 18-00 Local Time)
- 8424 data points

Historical Data - Forecast Weather

- Leveraged Air Force experience
  - World War II to present
- Factored in "expectations" for year 2010
  - 15% increase in accuracy over today
  - Presumes investments in weather assets
    - Sensing
    - Modeling
    - Applications

Data Analysis - Actual Weather

- Followed Sep 94 Checkmate paper
  - Composite of "friendlies" and "threats"
  - Weather composite based on averages
- Averaged each weather category

Band 1	5.6%	Band 4	13.9%
Band 2	2.8%	Band 5	13.9%
Band 3	5.6%	Band 6	58.2%

Production of JSF Weather Database

- Weather pattern created from frequencies
  - Points representing "pseudo" stations
  - 6 x 6 base matrix
  - Pattern resembles nature
- Pattern movement
  - Southeasterward in time
  - Achieved by manipulating columns and rows

Weather Pattern Matrix

6	6	6	6	6	6
6	6	6	5	4	6
6	6	4	1	3	5
6	5	1	2	5	6
6	3	4	5	6	6
4	4	6	6	6	6

6	6	6	6	6	6
6	6	6	6	5	4
5	6	6	4	1	3
6	6	5	1	2	5
6	6	3	4	5	6
6	4	4	6	6	6

Day 1

Day 1

00-06L

06-18L

Validation of JSF Weather Patterns
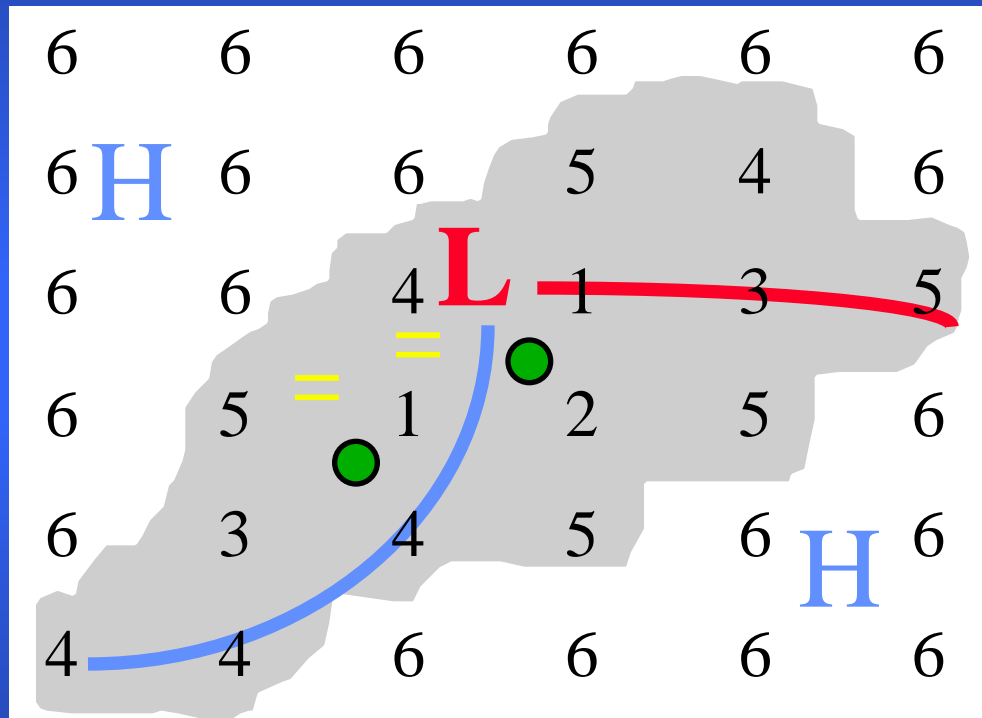
Weather Forecasts

- Based on real-world experience
- Accuracy related to frequency of occurrence
  - Higher for more frequent weather categories
  - Lower for less frequent categories
- Forecast weather pattern
  - Well correlated with actual weather pattern
  - Clouds with clouds, clear with clear, etc.

Modeling of Forecast Accuracy

Forecast Accuracy and Weather Band Frequency

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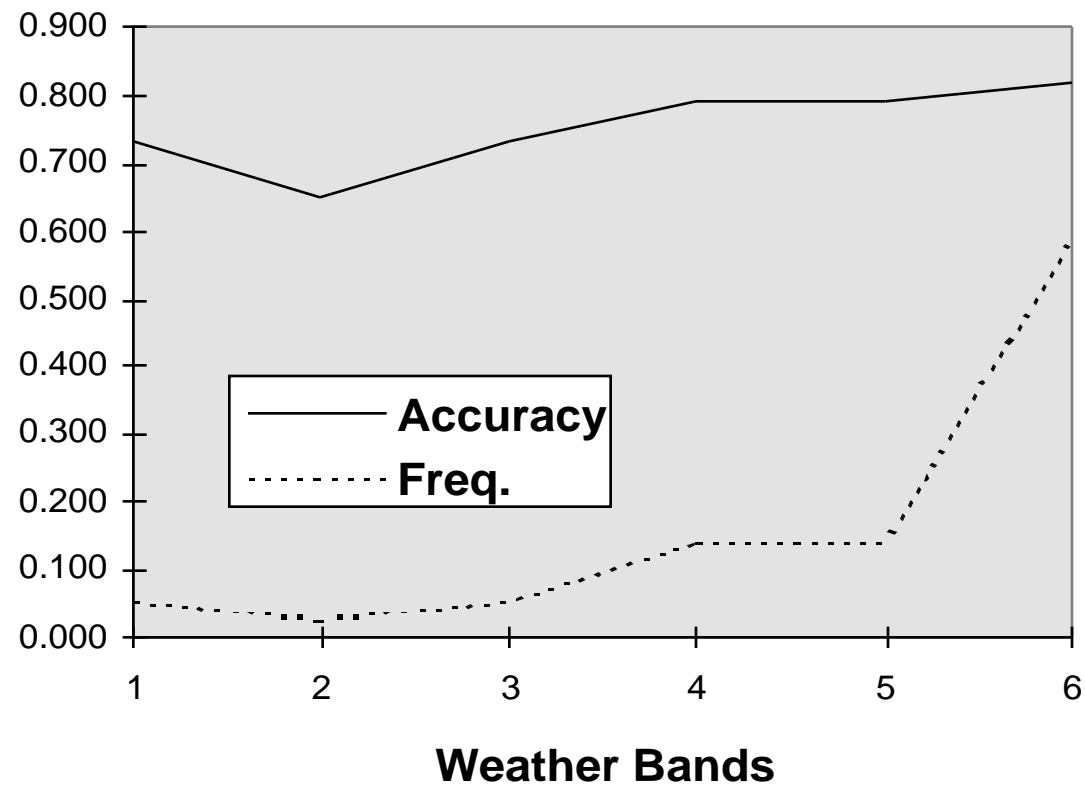
Modeling the Forecast

- Used Microsoft Excel, Visual Basic
  - Weather generation tools
- Forecasts modeled from actual weather
  - Random number method
  - Forecast estimated from actual weather
- Near misses more likely than large ones
  - Provides a realistic error distribution

Forecast Error Distribution

Forecast Band = 1
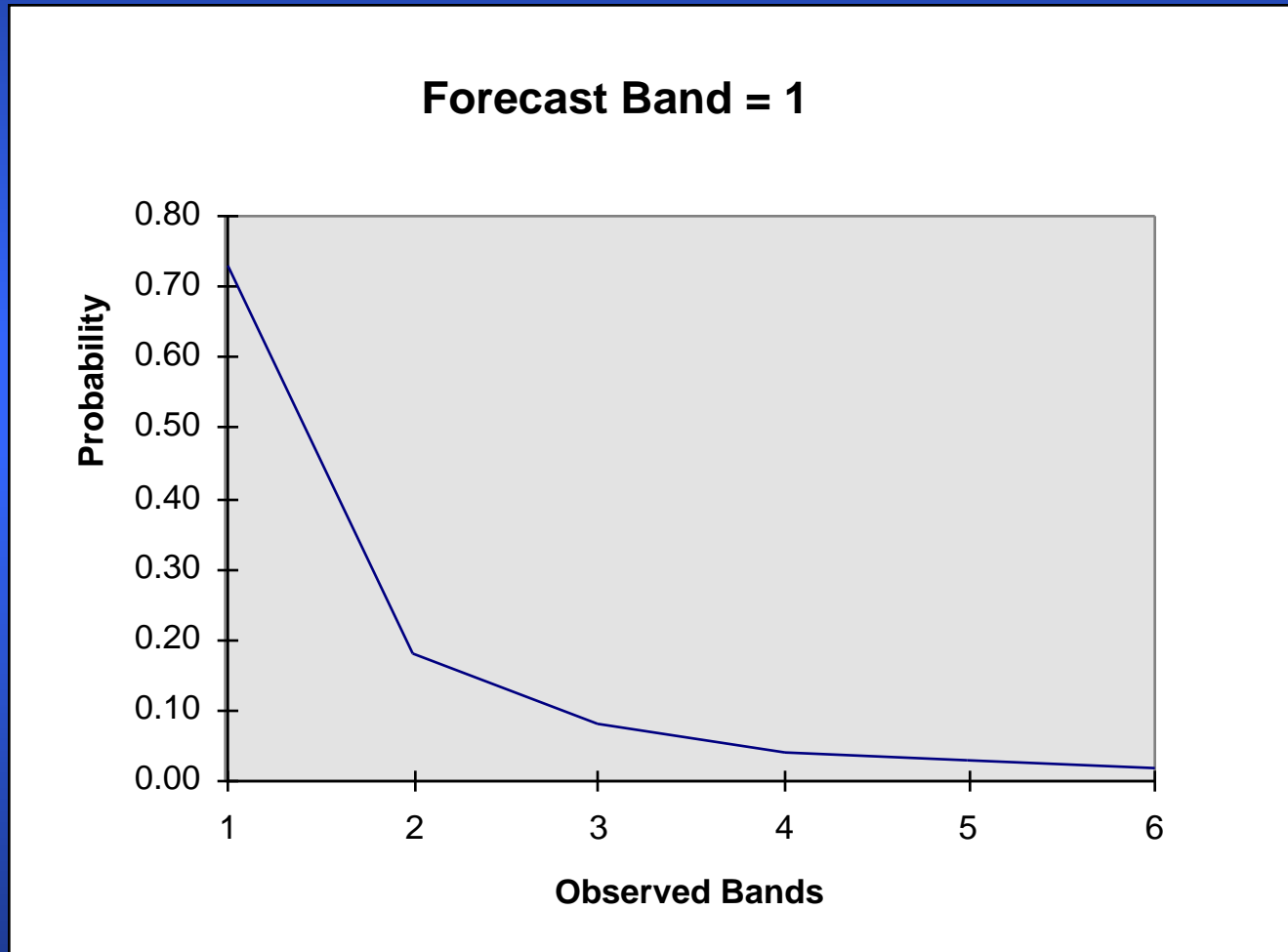
Verification

- Statistical verification of output
  - Actual weather database
  - Forecast weather database
- Behavioral verification of tools
  - Actual weather tools
 - Forecast weather tools

Validation

- Validation of output
  - Weather patterns compared to real world
  - Forecast accuracies compared to experience
- Face validation
  - Occurred when weather input and weather effects in the simulation output reasonably agreed with real-world experience in the eyes of the domain experts

Adjustments to Weather Input

- Expanded to cover more area
- Forecast error distribution refined
  - Did not reflect real-world errors
  - Enabled better modeling of weather effects

Example of Current JSF Weather
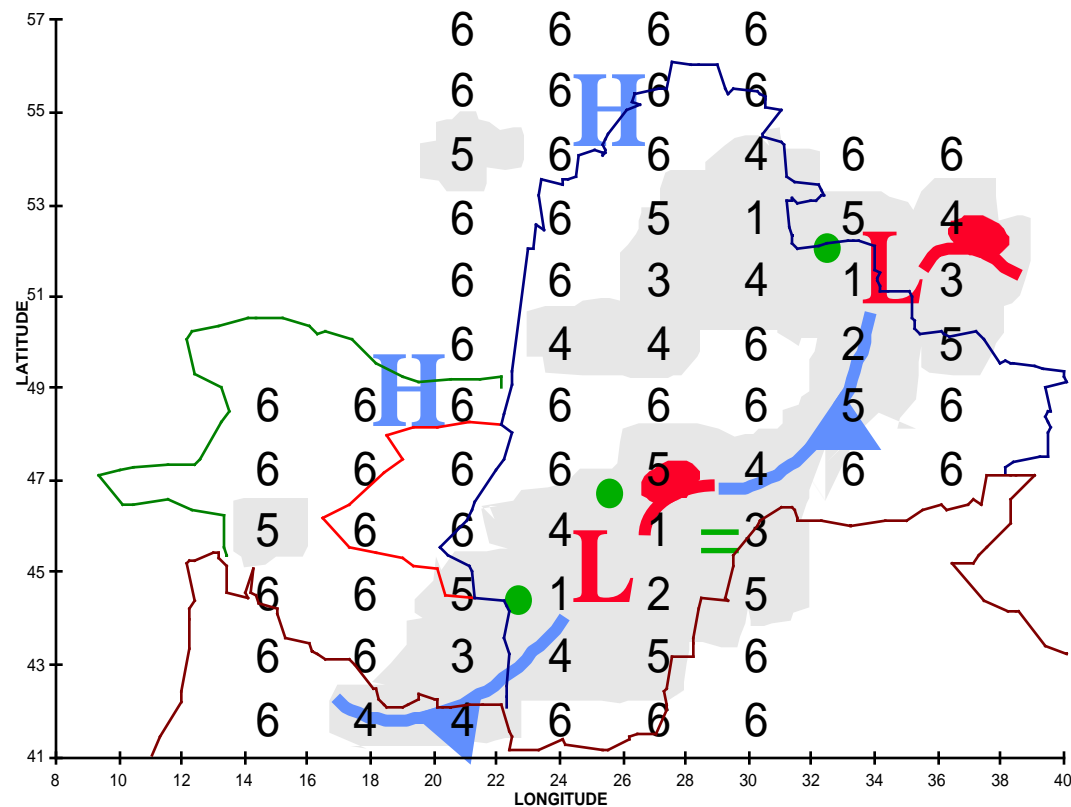
Baseline Database Pedigree

- In preparation
- Purpose
  - Describes the database process
  - Discusses verification and validation
- Incomplete draft available

Summary

- Verification and validation shows JSF weather database well represents real world actual weather and forecast weather

- Weather affects:
  - Warfighting configuration
    - Weapons loadouts (forecast weather)
  - Warfighting results
    - Mission execution (actual weather)
    - Target acquisition, weapons delivery, recovery